# BULLETIN

## OF THE INSTITUTE OF METALS

VOLUME 4 JUNE 1959 PART 22


## INSTITUTE NEWS

### Election of Members

The following 7 Ordinary Members, 3 Junior Members, and 14 Student Members were elected on 14 April 1959:

*As Ordinary Members*

CHAKRABARTY, Surja Kumar Sarma, Technical Assistant, Vickers-Armstrongs, Ltd., Bilston, Staffs.

CHOAN, Ko Kim, B.Sc., Philippine Blooming Mills Co., Inc., P.O. Box 2040, Manila, Philippines.

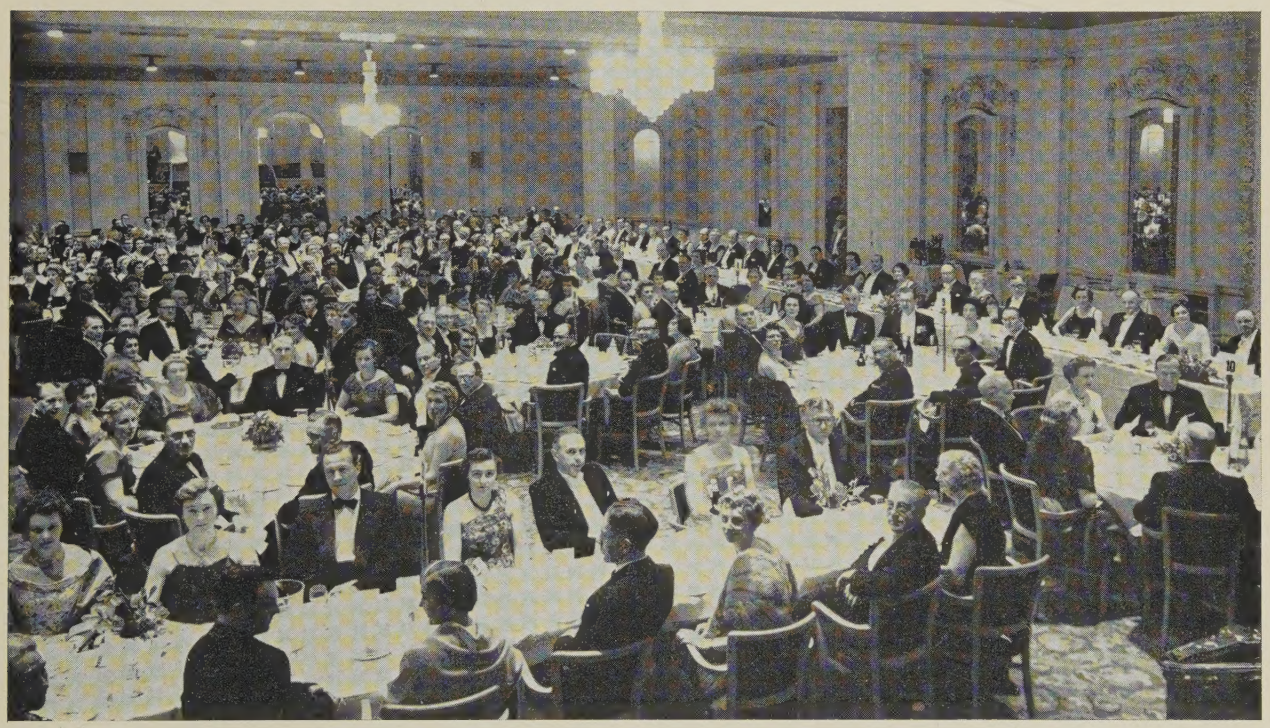
SANO, *Professor* Tadao, D.Sc., Professor of Nuclear Metallurgy, Faculty of Engineering, Osaka University, Miyakojima-ku, Osaka, Japan.

SCHILEO, Giancarlo, Metallurgist, Fiat-Sezione Energia Nucleare, Corso Bramante 15a, Torino, Italy.

*As Junior Members*

LOWE, Derek, B.Sc., Superintendent of Experimental Department, The British Aluminium Co., Ltd., Milton, Stoke-on-Trent, Staffs.

SMITH, Jesse Alan, Experimental Officer, U.K. Atomic Energy Authority, Dounreay Experimental Reactor Establishment, Thurso, Caithness.



Members and their guests at the Spring Meeting Banquet held on 15 April.

GARDNER, Douglas Stewart, Director and Works Manager, Glenfield and Kennedy, Ltd., Kilmarnock, Ayrshire.

JONES, Garth Owen, M.A., A.M.I.Mech.E., Factory Manager, Imperial Chemical Industries, Ltd., Metals Division, Waunarlwydd Works, Swansea.

KUSHNER, Joseph B., Ph.D., Ch.E., Met.E., Instructor in Physical Metallurgy, Evansville College, Evansville, Ind., U.S.A.

WARE, Barry, L.I.M., Works Metallurgist, Aston Chain and Hook Co., Ltd., Erdington, Birmingham 24.

*As Student Members*

BARDSLEY, Robert Edward, Student, Texas Western College, El Paso, Texas, U.S.A.

COLL, Jorge A., Lic. Cienc. Quim., Research Student, Department of Metallurgy, University of Birmingham.

CORREA-NUNEZ, Armando, Student, Texas Western College, El Paso, Texas, U.S.A.
DAVIS, Kenneth Jay, Student, University of Oklahoma, Norman, Okla., U.S.A.
DOERING, Harvey von Eggers, B.S., Graduate Student, Department of Metallurgical Engineering, University of Oklahoma, Norman, Okla., U.S.A.
ESCALANTE, Edward, Student, Texas Western College, El Paso, Texas, U.S.A.
FAULKNER, George Lawrence, Jr., Student, Texas Western College, El Paso, Texas, U.S.A.
HARRINGTON, Leslie W., Student, Texas Western College, El Paso, Texas, U.S.A.
HISTED, John Henry, Undergraduate, Department of Metallurgy, University of Cambridge.
MCDONALD, José, Jr., Student, Texas Western College, El Paso, Texas, U.S.A.
RODARTE-ROYO, Guillermo, Student, Texas Western College, El Paso, Texas, U.S.A.
RYDER, Bryan, Undergraduate, Department of Metallurgy, University of Oxford.
SHUNK, Francis Alexander, Student, Texas Western College, El Paso, Texas, U.S.A.
SORKIN, Alvin B., Student, University of Oklahoma, Norman, Okla., U.S.A.

# PERSONAL NOTES

DR. N. P. ALLEN has been elected an Honorary Member of Council of The Iron and Steel Institute.

PROFESSOR PAUL BASTIEN has been elected President of the Société Française de Métallurgie for 1959.

MR. N. T. BURGESS has left the Aluminium Development Association to join the Research and Development Department of the Central Electricity Generating Board as welding metallurgist.

DR. A. R. CHAUDHURI has left Massachusetts Institute of Technology and joined the Research Division of the Raytheon Manufacturing Co., Waltham, Mass.

MR. V. O. CUTTS has retired from his position as Manager of the Process Heating Department of The General Electric Co., Ltd.

MR. T. J. DENNIS has been appointed Divisional Manager, Rolling Division, High Duty Alloys, Ltd., Briton Ferry, near Neath, Glamorgan.

MR. H. E. DIXON has been appointed Head of Research and Development, Atomic Power Constructions, Ltd., and Head of the Company's Heston Laboratories.

M. MAX DUPONT has been appointed Secrétaire Général of the Société Française de Métallurgie in succession to Dr. Dupuy.

DR. E. L. DUPUY has relinquished the position of Secrétaire Général of the Société Française de Métallurgie, which he has held since the Société was founded.

MR. L. G. EARLE has been appointed a Director of H. J. Enthoven and Sons, Ltd.

DR. H. K. FARMERY has left the Fulmer Research Institute and is now at the Admiralty Materials Laboratory, Holton Heath, Poole, Dorset.

MR. R. C. GIFKINS, of the Commonwealth Scientific and Industrial Research Organization, is at present visiting Britain. He will return to Australia in July.

MR. R. D. HAMER has assumed the post of Chief Executive Officer for Aluminium Limited's international sales in Europe, the Middle East, and North Africa. His headquarters will be in Zürich.

PROFESSOR R. HAY, who recently retired from the Chair of Metallurgy in the Royal College of Science and Technology, Glasgow, is to receive the honorary LL.D. degree of Glasgow University.

PROFESSOR BO KALLING, until recently Director of Research, Stora Kopparbergs Bergslags AB, Sweden, has been awarded the Bessemer Gold Medal for 1959 by The Iron and Steel Institute.

MR. R. E. LENHART has left the General Electric Co., and is now with the Beryllium Corp., Reading, Pa.

MR. D. C. F. LUNN has been appointed Chief Metallurgist to Atomic Power Constructions, Ltd.

PROFESSOR A. J. MURPHY, Principal of the College of Aeronautics, has been elected President of the Institution of Metallurgists.

DR. L. B. PFEIL has been elected a Fellow of the Imperial College of Science and Technology, London.

MR. L. ROTHERHAM has been elected a Fellow of University College, London.

MR. C. R. TOTTLE has been appointed Professor of Metallurgy in the University of Manchester in succession to Professor F. C. Thompson, who is retiring. Mr. Tottle is at present Deputy Director of the U.K. Atomic Energy Authority, Industrial Group, Dounreay.

MR. T. HENRY TURNER has retired from his position with the British Transport Commission.

DR. J. F. WATKINSON has been appointed General Manager and Director of B.S.A. Metal Powders, Ltd., Birmingham. He was previously at the B.S.A. Group Research Centre.

DR. J. WILCOCK has left the Department of Industrial Metallurgy at the University of Birmingham to take up an appointment with Powder Metallurgy, Ltd., London.

### Deaths

The Editor regrets to announce the deaths of:

MR. ANDREW DANDO, who, until his retirement in 1957, was Chairman of Hall Street Rolling Co., Ltd., Birmingham.

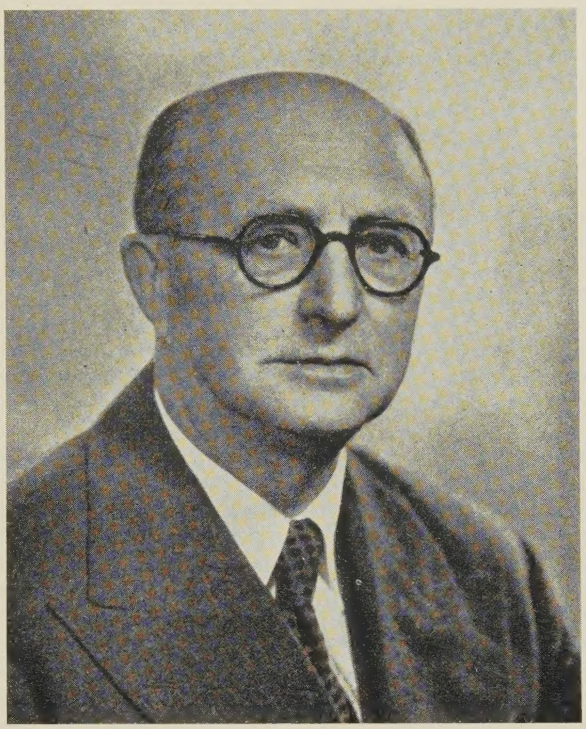
PROFESSOR EMERITUS WILLIAM MINOT GUERTLER at Berlin-Dahlem, on 21 March 1959, aged 79.

# OBITUARY

## Mr. H. S. Tasker

As already briefly reported in the *Bulletin*, Mr. H. S. Tasker, Past-President and Fellow of the Institute, died in the Radcliffe Hospital, Oxford, on 9 February.

Hubert Sanderson Tasker was born in 1885 and was the second son of the Rev. Dr. J. G. Tasker of Handsworth College, Birmingham. He was a Foundation Scholar of King Edward's School, Birmingham, changing from the classical to the modern side in 1902. He won an open scholarship in Natural Science to Emmanuel College, Cambridge, in 1904, and after obtaining a double first in the Natural Science Tripos (Chemistry Part 2), he held a College Research Studentship during 1908–09.



Entering industry, he joined Cookson and Co., Ltd., Newcastle-upon-Tyne, lead and antimony manufacturers, in 1909 as a trainee, developing first on the sales side and after in the managerial field. He became General Manager in 1919.

After the First World War the lead-manufacturing industry, like many others in this country, went through difficult times. There were far too many plants, a lot of them obsolete, and in some cases trading losses were being sustained. As one of the more progressive companies in the industry, Cookson and Co., Ltd., decided to attempt rationalization, and a start was made in 1920. Over the following 8 to 10 years the bulk of the lead-manufacturing interests in the United Kingdom were acquired by, or brought under the control of, Associated Lead Manufacturers, Ltd., a public company formed for this purpose. It was an exceedingly busy period, and as the company's first Managing Director a large share of the work fell upon Tasker's shoulders. His quick grasp of technical, commercial, and financial problems was of great service to the lead industry in this country. As a result of this rationalization, manufacturers were able to work under conditions of a reasonably stabilized market at home.

At the same time, the industry was faced with severe competition from abroad, and Tasker played an outstanding part in most difficult and arduous negotiations covering the years 1924 to 1927, as a result of which marketing agreements covering many countries were established. His wide knowledge of the industry, together with his ability and charm of character, won him many friends all over the world. These international trading arrangements came to an end with the outbreak of the Second World War.

In 1930 Associated Lead Manufacturers, Ltd., which was a large supplier of raw materials to the paint trade, decided to enter the industry as manufacturers and acquired Goodlass Wall and Co., Ltd. A new company, Goodlass Wall and Lead Industries, Ltd., was formed, and the organization and development of this was the chief concern of the remaining part of Tasker's business life. He became its first Managing Director in 1930, Vice-Chairman in 1940, and Chairman from 1947 to 1951. From then until 1957 he retained his seat on the Board.

Another notable achievement of his business career was his work from 1933 to 1955, as Vice-Chairman and subsequently Chairman, in the development of British Titan Products Co., Ltd., which grew under his guidance from a business of comparatively modest size to a highly successful enterprise.

In spite of his many business commitments, Tasker found time to undertake much useful outside work. He was a member of the Grand Council of the Federation of British Industries in 1922, 1932, 1933–34, and 1947–50. He was much concerned in furthering metallurgical education, and his interest and support while connected with the Institute of Metals contributed greatly to the establishment, on a sound footing, of the Joint Committee for Metallurgical Education and the Joint Committee for National Certificates in Metallurgy.

He joined the Institute of Metals in 1933 and held the following offices: Member of Council 1938–42, Vice-President 1942–45, Honorary Treasurer 1945–47, Member of Council 1947–48, Vice-President 1948–50, and President 1950–51. It was during his term of office as President that Tasker planned and successfully launched the Institute's first appeal to Industry for regular financial support. In 1954 he was elected a Fellow of the Institute in recognition of his long and distinguished services. He was also active in the affairs of the British Non-Ferrous Metals Research Association. Joining the Council in 1931, he became a Vice-Chairman in 1935 and in 1938 was elected to the Finance and General Purposes Committee.

Tasker was fond of outdoor sports and displayed a definite talent for cricket in his early days. His heart, however, really lay in gardening, and in his home at Stocks Wood, near Wareham, Dorset, he specialized in alpines, heaths, rhododendrons, and azaleas. Throughout the whole of his life he was an extremely hard worker. His intellectual gifts were coupled with real modesty, and his personal charm and kindness were recognized by all who knew him.

In 1912 he married Doris Lisle Holdsworth, daughter of the Rev. W. W. Holdsworth of Handsworth College, Birmingham, who survives him, with their two sons and daughter.

J. L. McC.

*Informal Discussion*

# THE ECONOMIC PROTECTION AND PACKAGING OF NON-FERROUS METALS IN STORAGE AND TRANSIT

**B19**

*A one-day Informal Discussion on "The Economic Protection and Packaging of Non-Ferrous Metals in Storage and Transit" was held under the auspices of the Metallurgical Engineering Committee at the College of Technology, Gosta Green, Birmingham on 17 February 1959. A large attendance included representatives of the non-ferrous metals manufacturers and fabricators, user industries, various Government Departments and interested technical associations, packaging material manufacturers, wrapping-machine manufacturers, and transport and insurance organizations and companies. Professor H. Ford, Chairman of the Committee, occupied the chair.*

*A summary of the proceedings, prepared by Mr. E. S. Hart, is given below.*

## Opening Addresses

OPENING addresses were given by Mr. L. J. SOPER (Northern Aluminium Co., Ltd.) and Mr. H. BASKERVILLE (Imperial Chemical Industries, Ltd.).

Mr. SOPER reviewed the method of packing generally used for aluminium and its alloys, in the forms in which it is commonly produced, both for the home and the export markets. He prefaced his remarks with a reference to the materials in general use, including wood, hardboard, and reinforced cardboard for exterior protection against mechanical damage; and kraft union, crêpe waterproof, waxed kraft, polythene and foil laminate papers for wrapping and case lining which demanded efficient waterproofing. Wood was generally favoured for case construction owing to its rigidity, and for the home trade cases could be used repeatedly.

Sheet was the principal product and gave rise to most problems. It was particularly important to protect it against wetting which might cause corrosion. This could arise from condensation followed by the intrusion of moisture between the sheets by capillary action, and demanded suitable storage conditions; but where conditions were particularly unfavourable, e.g. during shipment through tropical regions involving wide and rapid variations in temperature, special protection was needed for all types of product. It was also important, by the adoption of pressure packing, to prevent fretting due to movement of sheets within the case during transit. Interleaving with tissue paper, with or without the application of oil to the sheets, was sometimes advisable; this practice was mainly confined to sheet for aircraft.

Flat sheet might be packed in cases or on skids; but corrugated sheet, owing to its rigidity, could safely be despatched in bundles for the home market or in skeleton cases for export. Coil could usually be despatched loose, but for export it was advisable to give some protection, e.g. by wrapping in waterproof paper and plywood, the ends being covered with wooden discs. Plate presented few problems and could generally be transported loose. Extruded and drawn products for the home market were usually bundled; but for export, or where fragile material was involved, casing or wrapping with crêpe paper was often necessary. Tubes of various diameters could be telescoped to save space.

It was advantageous on economic grounds to combine inspection with packing, and the provision of mechanical aids, such as machines for banding, nailing, or wrapping, also deserved consideration.

A good deal of attention was being paid to the use of non-returnable packing, particularly for sheet for the home market, where adequate protection could be given by double corrugated cardboard. This saved carriage costs and relieved both the supplier and customer of much troublesome paper-work.

Mr. BASKERVILLE dealt particularly with the importance of the economic aspect of packaging because "a package in the non-ferrous metal trade always costs and never earns". Apart from the design and cost of the package itself, other factors also had a bearing on the overall economics of packaging; for instance, the operation of packing, the problem of handling by both the producer and the customer, and transport, were all of importance.

Discussing packing containers, Mr. Baskerville referred particularly to the necessity for excluding moisture, whether due to direct wetting by rain or sea water, or arising from condensation. He considered that the high capacity of softwood for absorbing moisture made it necessary to be very careful about its condition when using this material for case construction and quoted experimental results to illustrate its absorptive properties. For the packing of coils of strip his Company had, in a number of instances, avoided the use of softwood by using returnable plywood kegs, with the coils separated by cardboard discs.

The danger of condensation, which was particularly liable to occur in a ship's hold during passage through the tropics, could be minimized by reducing the amount of air that came into contact with the metal. He commended the guidance given in two publications dealing with this problem.*

Turning to case linings, he pointed out that materials must be selected to suit varying requirements and with due regard to economics. He had, for instance, found that for packing metallic cartridges the traditional tinplate linings could be replaced by completely sealed "Alkathene" film without loss of protection but with considerable saving in cost. Polythene films were also used for the packing of other products, particularly sheet; but they had to be strong, and precautions had to be taken to prevent movement of the sheets, or cutting of the film might occur. These films proved a more efficient moisture barrier than either tarred or plain kraft paper, but their cost was greater. Additional protection against moisture could be afforded by the use of chemical inhibitors such as silica gel, particularly with coils of strip, but this might prove expensive, and was difficult to use with sheet because cases were filled to capacity.

Freight charges demanded close attention when packing for

* "The Principle of Condensation", published by the Research Committee on Marine Moisture Damage of the Association of Marine Underwriters of British Columbia.
"Lloyds Survey Handbook".

export. If packages had a volume : weight ratio of 40 ft.$^3$/ton or more, freight charges would be on the basis of volume rather than weight and this could be relatively expensive.

## Discussion

Some of the main points in the interesting discussion that followed are summarized below.

Mr. H. Hodges (Henry Wiggin and Co., Ltd.) dealt mainly with certain factors common to the wide range of alloys based on nickel in which his Company was interested. Precautions were taken to remove harmful sulphur-bearing surface contaminants arising from production; it was therefore necessary to avoid the presence of these harmful substances during storage and packing. Nickel was particularly susceptible to contamination by heavily polluted industrial atmospheres, but the nickel–chromium, nickel–copper, and nickel–iron alloys might also be affected, and the last-named was subject to rusting in damp atmospheres and was therefore packed with strips of vapour-phase-inhibitor paper to reduce the effects of condensation.

To avoid scratching and other surface damage, not only was handling reduced to a minimum, but inspectors and packers wore clean cotton gloves which afforded protection against stains arising from perspiration. Sheet and strip were protected by interleaving with cardboard during the later handling processes, and with tissue paper in the final pack. Coils were finally enveloped in crêpe paper to protect them from scratches, dust, and atmospheric pollution. Stock was turned over in strict sequence of production to avoid unnecessarily prolonged storage.

Mr. Hodges stressed the economic factors involved in the use of stacker-trucks and palletization and, where feasible, he also favoured the adoption of non-returnable cases, drums, and reels. Nickel and nickel alloy bright-finish sheet was packed in wooden cases lined with pitch paper followed by corrugated strawboard, the sheets being interleaved with tissue paper to prevent scratching. Oak, sweet chestnut, and cedar were regarded as unsatisfactory for case construction because of their tendency to give off moisture.

Wooden reels had been used for the packing of wire, but dimensional changes associated with unseasoned wood had led to difficulties, and plastic reels were now preferred. These withstood more journeys, were cheaper, and were also favoured on account of their constant weight and dimensional stability.

Reference was made to the importance of suitable designs for labels and tags to ensure that goods arrived at the destination accompanied by the considerable detail required by customers and necessary to provide full identification. Particulars were entered by automatic printing machine and not in manuscript.

Mr. S. G. Rydings (British Transport Commission) emphasized that the most important consideration was to ensure the satisfactory condition of goods on delivery—which implied adequate packing—and that this must not be subordinated to considerations of cost or the standard of packing would probably suffer.

He proceeded to discuss the main causes of damage to goods in storage and transit. First, a type of packing must be adopted that was suited both to the nature and the value of the goods and to the form of transport and storage, due regard being paid to cost. Secondly, it was often necessary in the case of home deliveries, and still more in that of exports, to apply protection to prevent corrosion or deterioration including, for instance, coatings or dippings of resin, greases, oils, strippable plastic coatings, cocooning and the use of vapour-phase inhibitors. Thirdly, handling was an important consideration which was related to the size and weight of the packages, the method of transport—including the necessity to handle or transfer in transit—and the effective securing of the packages within the vehicle. Fourthly, conditions of storage, including duration, humidity, and handling equipment available, had to be carefully considered.

Where aluminium sheets were concerned, Mr. Rydings emphasized the importance of freedom from dust, and tight packing. He recommended the use of dry cases containing not more than about 18% moisture, but deprecated the employment of oak, chestnut, or cedar unless unavoidable. He claimed that nails were often inadequate both in size and number; cement-coated nails were to be preferred. Fibreboard and paper-pulp products, if of good quality, showed satisfactory durability and water-resistance. Double corrugated fibreboard packs had travelled with considerable success. The fibreboard should conform to the standard laid down in the Railway Clearing House Regulations.

Mr. W. D. Rance (High Duty Alloys, Ltd.) stressed the advantages of the non-returnable packing which his Company had adopted for ordinary commercial and also for aircraft customers. The aluminium sheets, enveloped in kraft union paper, were carried on a fibreboard base to the underside of which was nailed a light wooden stillage. The top, of fibreboard, was bound longitudinally and transversely with steel strapping. The cost of this pack was approximately 0·3*d*/lb. A returnable square stillage with runners and wooden top was used for circles.

Mr. H. Taylor (Northern Aluminium Co., Ltd.) in referring to the interleaving of aluminium sheets with tissue paper to prevent fretting, emphasized the accompanying danger of corrosion. Paper with a moisture content of 8–10% was not regarded as corrosive, but chloride and acidity should not exceed 0·05 and 0·1%, respectively, and even below these limits, corrosion might occur. With good-quality tissue it was unnecessary to use inhibitors.

For the outer wrapping he regarded kraft union, sealed with gummed paper, as generally the best material. Plastics were difficult to seal and required corner protection. Vapour-phase-inhibitor papers added considerably to the cost and were not very effective. The moisture content of wooden cases was not regarded as a serious danger.

Dr. F. A. Champion (The British Aluminium Co., Ltd.) stated that in regard to impurities in tissue paper, i.e. chloride, sulphate, and *p*H value, his Company worked to the Chemical Inspectorate specifications of the Ministry of Supply.

Entry of water vapour was a more prevalent hazard than entry of liquid water and was mainly dependent on the length of the journey, the variation in climatic conditions, and, in particular, the number of cycles. The outer wrapping should be effectively sealed or water vapour would be drawn in as a result of breathing of the pack, and condensation might occur, particularly on the sharp edges of the sheets. Gummed paper strip could not afford a really effective seal, but to close all joins in a kraft union lining was in practice extremely difficult, if not impossible.

Polythene was liable to tear in transit. Vapour-phase

inhibitors were not reliable on aluminium, and impregnated tissue papers were costly. Mouldable waxed wrap afforded good protection against moisture but was expensive and might be liable to mould growth. Sodium benzoate was an unacceptable inhibitor for use with aluminium owing to its alkalinity.

Fretting usually resulted from microscopic relative movement between two surfaces in contact under pressure rather than from true abrasions caused by grit. Tissue paper afforded the best protection; oiling was detrimental in that it aided that slight movement.

Mr. Ross (Fairey Aviation Co., Ltd.) in emphasizing the importance of avoiding scratches and surface defects on aluminium sheets for stressed-skin work, drew attention to the protective materials based on the acrylic polymers, one of which, dispersed in trichloroethylene, had recently been examined by his Company. He enquired whether it would be economical to supply sheet and extrusions coated with this polymer, which, when required, could be readily removed by degreasing.

He deprecated the use of sealed packages for the fabricated assemblies with which aircraft manufacturers were concerned; in a totally enclosed atmosphere the wide variety of materials that might be included, both organic and inorganic, could give rise to dangerous interactions.

Vapour-phase inhibitors must be used with considerable caution, as they may lead to accelerated corrosion. Some woods were dangerous on account of acidity, which might be particularly injurious to cadmium, zinc, and possibly copper. For valuable aircraft items, packages based on hair or fibre, bonded with rubber or plastic material, were preferable to the use of wood wool or shavings; in the sphere of packaging for the Services, however, the procedure was largely controlled by the requirements of Specification EF.1234.

Mr. H. G. Cole (Ministry of Supply) in discussing the particular problems associated with long-term storage referred to the dangers arising from organic vapours given off by certain packing materials. In regard to vapour-phase inhibitors, no general recommendation could be made; their behaviour depended upon so many variables that their suitability should be determined for each application by testing under the actual conditions to be met with in service.

Mr. P. N. Heron (Printing and Allied Trades Research Association) dealt mainly with the testing of packages and packaging materials. His experience had shown that the suitability of a particular method of packing, and of the packing materials employed therewith, could best be determined—on grounds of economy and speed—by laboratory tests rather than by the behaviour of packages under actual conditions of service.

The criteria for testing were protection against mechanical damage and resistance to climatic effects. Since these factors might interact, it was important that they should be tested concurrently and not separately. For instance, mechanical damage might result in ingress of moisture, or, conversely, wetting might weaken packing materials to an extent sufficient to reduce appreciably their resistance to mechanical damage.

The wide variety of tests which he was accustomed to apply included the examination of papers and boards to determine the presence of deleterious materials, and to ascertain their moisture-vapour permeability—which was important when reliance was being placed on a desiccating agent, such as silica gel, to absorb incoming moisture. Resistance to damage by rain, salt spray, or condensation, was investigated by shower or salt-spray tests on the completely sealed package. Accelerated storage tests under extreme conditions of temperature and humidity were also carried out; but it was not advisable to accelerate normally achieved effects by more than about 8–10 times or the results might be misleading.

Tests to ascertain the resistance of a package to mechanical damage might include dropping, the imposition of blows and shocks to simulate the effect of railway shunting, vibration at various frequencies, and compression tests. These tests were interspersed with climatic tests.

Mr. E. G. Slingsby (The British Aluminium Co., Ltd.) described the practice followed by his Company in the handling, packaging, and storage of aluminium, in various forms, with fine finishes. This type of product, used mainly for reflectors or decorative purposes after anodic treatment, called for better protection against mechanical damage than the ordinary commercial products. Handling should be reduced to a minimum and the packing operation carried out in a warm, dry atmosphere free from grit.

Rigidity was essential in regard to case design and for small sizes of sheet, strip, coil, and circles, panel-ended cases were used. The same applied to sections and tubes where the cross-section of the case exceeded 12 in. square. For larger sheets the traditional type of case was employed, but, to provide stability and to protect the contents from superimposed loads, it was desirable to provide an external lid. Net weight of packages containing sheet, coils, and circles was limited to 5–6 cwt., though for sections up to 7 cwt. was allowed.

The material was protected from the case bottom by a sheet of 40-oz. strawboard. If long storage was anticipated, a case lining of kraft polythene laminate was employed, but normally kraft union was suitable; the lining was sealed with a waterproof cloth tape having a self-sealing zince oxide adhesive. For storage in tropical or sub-tropical conditions, the case lining should be of aluminium foil laminated to a cellulose film and coated on both sides with a heat-sealable coating. Sometimes a soldered tinplate lining was employed.

Interleaving was invariably demanded. Sheet, strip, and circles of thickness exceeding 22 S.W.G., together with soft-temper material of all thicknesses, were interleaved with two-ply cellulose wadding; for thinner material, tissue paper was employed. Sections were interleaved and tied in bundles of suitable size either with string or, when particularly liable to damage, with Scotch tape.

To ensure freedom from movement within the case, sheets were pressed firmly against one side and end of the case, followed by very careful wedging—often with strawboard or plywood interposed between the wedges and the metal. If the free space was too wide for the ready use of wedges, a stool could be used; this method was always to be preferred when thin or soft-temper sheet was concerned. Careful blocking and internal battening were necessary for sections and tubes, and the latter called for very generous padding.

When available, packing papers were always purchased to comply with the recognized specification, e.g. SC. 1993 for kraft union, SC. 2191 or SC. 2501E for waterproof tape, and SC. 2132C for foil laminate. Reasonable limits for corrosive agents were as follows: chloride NaCl 0·05%; sulphate $Na_2SO_4$ 0·25%; copper 0·01%; *p*H value 5·5–7·5. Materials for interleaving, particularly cellulose wadding, should be stored in a dry heated area with a relative humidity of 50–60%.

Mr. E. A. Bolton (Imperial Chemical Industries, Ltd.) touched on the importance, owing to danger of staining, of protecting certain materials from contact with workers' hands.

Mr. Barker (Carr and Co. (Paper), Ltd.), in discussing the properties of various packing papers, emphasized the importance of watching the chemical properties. Where non-ferrous metals were concerned, alkalinity could not be overlooked. Objection to the use of mouldable wax wrap on the ground of mould growth could be removed by the incorporation of a mould inhibitor. Tissues for interleaving should be free from undigested pulp and grit.

Kraft union had been a deservedly popular material, but kraft papers were now available with laminations of waxes, and blends of wax with synthetic rubber, which provided a more efficient water barrier than the lamination of bitumen.

He referred to another type of moisture barrier material—the vanillidine chloride copolymers—and claimed that coatings of these substances give outstandingly good results. For instance, whereas kraft union paper with a bitumen lamination might give values of 25–30 g./m.$^2$ under tropical test conditions on the P.A.T.R.A. test, these coatings would give 1–2 g./m.$^2$. They also provided a good barrier to gases.

Mr. J. E. Taylor (Evan Cook's Packers, Ltd.) enumerated the basic principles involved in the packing of machines and assemblies of widely differing size for export as: acclimatization before packing, adequate cleaning and protection where possible by temporary rust preventive, reduction as far as possible of hydroscopic materials, and use of the correct amount of desiccant, within a properly sealed moisture-vapour barrier.

Mr. D. Tonkinson (Wm. Palfrey, Ltd.) pointed out that it was now possible to treat pulp to produce kraft paper with a *p*H value of 7, which, being neutral, should be incapable of producing stain or corrosion on a metallic surface. In regard to paper for interleaving, he considered that there were no substitutes for tests in the field.

Mr. L. J. Sliney (Telephone Construction and Maintenance Co., Ltd.), referring to the polythene laminates, drew attention to the widely differing reinforcements, ranging from low-substance papers to hessian and other textiles, which gave a very wide range of bursting strengths and moisture permeabilities. Unfortunately their cost was relatively high, though there had been some reduction in recent years.

Mr. C. H. Bridgen (British Road Services) stated that his main problem was not mechanical damage but condensation and, in referring to tests which he was carrying out with different sheeting materials, he reported that while completely impervious materials such as plastic sheets gave excellent protection against direct wetting, they unfortunately attracted condensation; in consequence, flax-type materials with either a silicone or a chemical treatment were preferred.

He stressed the necessity of providing good protection against mechanical damage for small packages which might be trans-shipped two or three times in transit.

Mr. R. A. Jones (High Duty Alloys, Ltd.) mentioned that his Company had successfully used non-returnable packs with road transport for two years, but they had not been successful with rail transport. Sheets up to 96 × 48 in., always interleaved with tissue paper, were packed in this manner.

Mr. Fisher (Northern Aluminium Co., Ltd.) doubted the wisdom of using cheap non-returnable packing with mixed loads of widely differing products, often with several deliveries, and considered that in such circumstances both hauliers and insurers might object.

# POWDER METALLURGY JOINT GROUP

## " Theoretical Aspects of Sintering "

The fourth meeting of the Powder Metallurgy Joint Group was held in London on 29 April 1959, when an informal discussion took place on " Theoretical Aspects of Sintering." The discussion was based on five specially invited review papers, which were published beforehand in *Powder Metallurgy*, the official organ of the Joint Group. The papers were: " Processes Involved in Sintering ", by R. G. Bernard (Université de Lyon); " Recent British Developments in the Theory of Sintering ", by G. A. Geach (A.E.I. Research Laboratory); " Current Progress in Theories of Sintering in the U.S.A.", by J. T. Norton (Massachusetts Institute of Technology); " Recent Developments in Theoretical Aspects of Sintering in the German Democratic Republic ", by F. Thümmler (Dresden); and " The Mechanism of Sintering in Single-Component Systems ", by I. M. Fedorchenko and R. A. Andrievsky (Kiev).

## " Powder Metallurgy " No. 3

The latest issue of *Powder Metallurgy* contains, in addition to the five papers on sintering mentioned above, a number of original research papers, synopses of which are given below. *Powder Metallurgy* is published twice a year and is obtainable by annual subscription at 25*s*. (post free). Members of The Iron and Steel Institute and The Institute of Metals may obtain this periodical for a fee of 10*s*. per annum (post free).

### The Compaction of Metal Powders by Rolling. I.—The Properties of Strip Rolled From Copper Powders

By P. E. Evans and G. C. Smith

(*Department of Metallurgy, University of Cambridge*)

The investigation described is an extension of earlier work (" Symposium on Powder Metallurgy 1954 ", p. 131. **1956**; London (Iron and Steel Institute), and *Sheet Metal Ind.*, 1955, **32**, 589), which described the effect of rolling pressure and sintering conditions on the mechanical properties of strip rolled from copper powders. The directional variation of U.T.S. and of elongation of sintered strip are shown to be the same as those of solid copper with a similar microstructure, at least for material with up to 16% porosity. The shape of powder particles and the particle-size distribution have a marked effect on the strength of sintered strip by virtue of their effect on the shape and size of the pores in the sintered material. Measurements of electrical resistance reveal a linear relationship between conductivity and porosity over wide ranges of porosity in both " green " and sintered strip. The conductivity increases rapidly during the first few minutes of sintering at 1000° C. Measurements of the resistance in the rolling direction and in the transverse direction, which are

independent of local variations in density, have been made on green sheet; the resistance in the rolling direction is the higher. A correlation between this result and the mode of particle deformation is proposed, and is elaborated in Part II of this paper.

**The Compaction of Metal Powders by Rolling. II.—An Examination of the Compaction Process**

By P. E. Evans and G. C. Smith

(*Department of Metallurgy, University of Cambridge*)

The compaction process is examined in detail. It is shown that, where particle deformation is concerned, compaction by rolling is similar to compaction by static pressing, with the addition of elongation of the particles in the rolling direction when the rolling pressure is sufficiently high. A method for determining the average roll pressure is described. A comparison of the rolling of a metal powder with the rolling of a solid bar, and the determination of the effect of particle shape and mean size, indicates that not only roll/powder friction but also the slip between particles plays an important role in the compaction process. This leads to an examination of the flow properties of powders, which are measured in terms of a " powder-viscosity factor " that indicates whether and at what order of rolling speed a powder can be coherently compacted. Finally, a mechanism of compaction is proposed on the basis of the present findings and on the authors' earlier work.

**Production of Pure Nickel Strip by the Direct-Rolling Process**

By D. K. Worn and R. P. Perks

(*The Mond Nickel Co., Ltd., Development and Research Department, Birmingham*)

Results are presented of an investigation into the production of pure nickel strip, 6 in. wide × 0·030 in. thick, from carbonyl-nickel powder, using compacting rolls $7\frac{5}{8}$ in. in dia., arranged in a horizontal plane. Special reference is made to the factors affecting the quality and output of green strip: roll-gap dimensions, the head of powder above the roll gap, rolling speed, and raw-material properties. It is shown that for a given compacting mill, the thickness of green strip that can be produced is strictly limited and that it becomes progressively more difficult to achieve the limiting thickness with increase in rolling speed. A method of reducing the detrimental effect of high rolling speeds is described.

The continuous sintering and subsequent processing of directly rolled strip, using conventional cold-rolling and annealing plant, are then considered, and the properties of fully processed material are compared with those of strip produced from melted and cast carbonyl-nickel pellet. It is concluded that the direct-rolling process is capable of producing on a commercial basis nickel strip having properties which compare favourably with those of conventionally produced material.

**The Removal of Internal Porosity in Copper**

By B. Clapson and D. A. Robins

(*Research Laboratories, The General Electric Co., Ltd., Wembley*)

Observations on the removal of internal porosity in copper have shown the importance of grain boundaries in the sintering process. Grain boundaries act as strong vacancy sinks in contrast to twin boundaries and dislocations, which apparently do not absorb a large number of vacancies. It is concluded that, in copper, the mechanism of sintering is that of the diffusion of vacancies to the grain boundaries, where they are destroyed by the progressive removal of planes of atoms adjacent to the boundaries.

**The Influence of van der Waals Force on the Sintering of Glass**

By R. Bullough and F. O. Jones

(*Research Laboratory, Associated Electrical Industries, Ltd., Aldermaston, Berks.*)

The contribution of van der Waals forces to the sintering of glass particles has been estimated. The contribution appears to be small relative to surface-tension forces in practical cases, but may be of importance in the formation of the initial bond during sintering.

**The Oxidation of Hot-Pressed Titanium Carbide and Titanium Boride in the Temperature Range 300°–1000° C.**

By N. F. Macdonald and C. E. Ransley

(*The British Aluminium Co., Ltd.*)

The oxidation characteristics of pure hot-pressed titanium carbide and titanium boride ($TiB_2$) have been studied in the range 300°–1000° C.

Titanium carbide shows a very marked peak in the rate of oxidation at ~450° C., the oxidation product at this temperature being anatase ($TiO_2$), which is powdery and non-adherent; the oxidation thus follows a linear law. Above ~700° C. the rate increases rapidly again and is approximately parabolic. The scale in this case consists of a dense crystalline film of rutile.

The oxidation of the boride is less rapid than that of the carbide over the whole temperature range but it, too, shows a slight peak at 450° C. The oxidation tends to be parabolic at higher temperatures. The nature of the oxidation products has not been determined.

# OTHER NEWS

## Prize Essays on Forgings

The National Association of Drop Forgers and Stampers announces three awards of up to £50 as prizes for written papers on a subject directly related to " The Production and Processing of Forgings." The closing date for MSS. is 1 September 1959. Further details and copies of the rules governing the awards may be obtained from The Technical Officer, National Association of Drop Forgers and Stampers, 245 Grove Lane, Handsworth, Birmingham 20.

## Sixth International Galvanizing Conference.

The Sixth International Conference on hot-dip galvanizing is to be held in Cannes, France, in May 1961. The Conference will be organized by the European General Galvanizers Association; detailed arrangements in France will be made by its member, the Association Technique Française de Galvanisation.

Subjects for discussion at the Conference will include some or all of those mentioned below, and persons interested in submitting original papers for presentation at the Conference are asked to communicate with the organizers.

# FOUR NEW BOOKS FROM THE AMERICAN SOCIETY FOR METALS

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## POWDER METALLURGY IN NUCLEAR ENGINEERING

An invaluable reference to today's powder metal advances

Almost without exception, the work described in Powder Metallurgy in Nuclear Engineering was sponsored by the U.S. Atomic Energy Commission. Excellently organized by Henry H. Hausner, Consultant to Sylvania-Corning Nuclear Corp., this volume is an invaluable reference for those who are acquainted with today's powder metal advances, and also for those who are now becoming involved with the tremendous potential of this essential aspect of metals technology.

Fifteen outstanding chapters include such vital topics as New Methods of Powder Metallurgy, General Metallurgical Problems in the Design of Nuclear Reactors, Alloying by Powder Metallurgy, and Safe Handling of Pyrophoric and Radioactive Metal Powders. For all that is known and for all that is new in powder metallurgy for nuclear engineering, send for your copy today. $8.50—275 pages—6 × 9—red cloth—illustrated.

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This important new book is the most complete collection of scientific and engineering information on what happens to metals in air vehicles and missiles during high-speed flight. In twelve chapters and five appendices, twenty-two authors deal with the metals problems that will determine the rate at which these new vehicles and missiles can be developed. Dealing primarily with the thermal barrier, the thermal thicket, this book emphasizes the need for study of environments formerly unknown or of only theoretical interest. It emphasizes that rapid advances in development of vehicles and missiles have made it urgently necessary to learn to cope with these environments.

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### INCIDENTALLY . . .

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Papers are required on: Works practice in general galvanizing, bath heating and control, galvanizing equipment, pretreatment of steel for galvanizing, metallurgy of galvanizing—influence of steel and bath composition, after-treatments of galvanized steel, the treatment of residues, corrosion of galvanized coatings, quality control in galvanizing, and sheet, wire, and tube galvanizing.

A general description of the work to be covered should be sent as soon as possible. A full outline of the paper will be required by May, 1960, and provisional selection of papers will be made at that time. Papers accepted for presentation at the Conference will be required in full by 1 November, 1960. For further information, please write to the Zinc Development Association, Secretary to the E.G.G.A., 34 Berkeley Square, London, W.1.

### Conference on the Fracture of Engineering Materials

The Eastern New York Chapter of the American Society for Metals is sponsoring a conference on "The Fracture of Engineering Materials" on 23–25 August at Rensselaer Polytechnic Institute, Troy, N.Y. There has been considerable activity recently in the study of fracture as a problem in metal physics. An international seminar on "The Atomic Mechanisms of Fracture", held on 12–14 April 1959, at Swampscott, Mass., attests the increasing interest in this problem. Whereas, however, the understanding of fracture mechanisms is currently receiving great emphasis, the interpretation of the present state of knowledge to the practising engineer is no less important. It is the aim of the August conference to fill this need by reviewing the current status of the fracture problem as it relates to materials of interest to the metallurgical, materials, and mechanical engineer.

A tentative programme for this conference has been prepared which includes topics of major interest. National authorities who are working in these selected fields (including W. A. Backofen, R. Davis, M. Gensamer, R. W. Guard, G. Irwin, J. R. Low, M. J. Manjoine, G. Sinclair, and R. D. Stout) have agreed to present these reviews, which will subsequently be published in a bound volume that will be available to registrants at a reduced cost. Abstracts will be distributed at the conference.

A conference fee of $10.00 will be charged to cover costs. Rensselaer Polytechnic Institute has graciously offered on-campus dining services and overnight accommodation to those attending the conference.

Information regarding the conference may be obtained from Richard W. Hardt, General Engineering Laboratory, General Electric Company, 1 River Road, Schenectady, N.Y. Registrations to attend the conference should be made with Dr. Ernest Nippes, Rensselaer Polytechnic Institute, Troy, N.Y.

# APPOINTMENTS VACANT

**ASSISTANT METALLURGIST** required by Consulting Engineers for London Testing Laboratories. Work includes wide range of testing, investigation of failures, micro work, welding, &c. Applicant should be capable of organizing work, writing reports, and working on own initiative. Salary up to £1000 per annum. Write full details to Box No. 446, The Institute of Metals, 17 Belgrave Square, London, S.W.1.

**BIIC**

**METALLURGISTS** required for the Shepherds Bush Research Laboratories of British Insulated Callender's Cables, Ltd., for fundamental and development projects on materials and manufacturing processes. Applicants should be of graduate or equivalent level and preferably have had some previous research or industrial experience. Applications should be made to the Personnel Officer, British Insulated Callender's Cables, Ltd., 38 Wood Lane, Shepherds Bush, W.12.

**BIRLEC HEATING DIVISION** Sales Department want Furnace Design Engineer. Duties include discussions with customer and liaison with Engineering Department Designers and estimators and preparation of Project and Tender Specifications. H.N.C. or Engineering Degree standard. Apply to Personnel Manager (JMP) Birlec Limited, Tyburn Road, Birmingham 24.

**ENGINEER-METALLURGIST** for process control in new alloy production plant in Ireland. Knowledge of modern foundry practice and control of complex alloys, with suitable technical education, necessary. Management of plant will be expected in two years. Terms of employment by agreement. A shareholding, based on service may be offered to a man capable of an outstanding contribution. Age under 30. Full details of experience, training, and personal circumstances required. Interview London. Box No. 447, Institute of Metals, 17 Belgrave Square, London, S.W.1.

**METALLURGIST.** Well-known American glass company seeking metallurgist or metallurgical engineer for employment in U.S. Location—New York State. Desire 4–8 years' experience in castings and forgings, familiar with stainless steel, high-temperature metals. Work involves development and application of materials to glass-forming dies. Personal interviews will be arranged with promising applicants. Box No. 449, Institute of Metals, 17 Belgrave Square, London, S.W.1.

**METALLURGIST** required by The Aluminium Development Association for work in the General Metallurgy Department. Duties include investigations into new applications of aluminium and its alloys particularly with reference to welding and welding fabrication, answering technical enquiries, and preparing reports and reviews. Applicants should be Graduates in Metallurgy or hold the Institution of Metallurgists' qualifications, with some industrial or laboratory experience. Commencing salary will be according to qualifications and experience. Applications giving full details should be sent to The Technical Director, The Aluminium Development Association, 33 Grosvenor Street, London, W.1.

**METALLURGISTS** required for control and development work on the production of non-ferrous metals. A degree or equivalent qualification is necessary, with industrial experience. Age should not exceed 30 years, and an adequate salary will be paid according to qualifications and experience. The posts have very good prospects of advancement with a progressive and expanding company. Apply in confidence to the Labour Manager, Enfield Rolling Mills, Ltd., Brimsdown, Enfield, Middlesex.

**PHYSICAL METALLURGISTS**

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Technical areas of current interest include: Phase Diagrams, Transformation Kinetics, Solidification Studies, Solid-Solution Strengthening, Mechanisms of Fracture, Stress-Corrosion, Fibre Metallurgy, Dispersed-Phase Activities, and High-Temperature Alloys.

If you are an experienced research metallurgist interested in and qualified for any of the above technical areas, send a complete résumé to:

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